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On
Steam Engines
Thomas Wilson.
— Truro. 1792. —

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A
COMPARATIVE STATEMENT
OF THE EFFECTS OF
Meſſrs. BOULTON AND WATT's
STEAM ENGINES,
WITH
NEWCOMMEN's AND MR. HORNBLOWER's.

TRURO:
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June 4, 1938
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TO THE LORDS OF
AND
ADVENTURERS IN
MINES in CORNWALL.

AS the Merits of Meſſrs. BOULTON and WATT's improvement of STEAM ENGINES have of late Years been much depreciated, and the ſuperiority of Mr. HORNBLOWER's over them hath been aſſerted, and generally believed, I take the Liberty of ſtating to you real Facts reſpecting theſe points, and leave you to decide on the caſe.

I ſhall begin with laying before you a Comparative Account of the performance of NEWCOMMEN's, or the old, Engines, and thoſe of Meſſrs. Boulton and Watt.

I am informed by Mr. MATTHEW MOYLE of Chaſewater, who was Agent of Chaſewater Mine when wrought by two Engines of the old Conſtruction, that thoſe Engines conſumed in Winter 7 Weys, and in Summer 5 Weys of Coals per day, of 64 Buſhels each, and that the average may fairly be deemed 6 of ſuch Weys per day.

One of Boulton and Watt's Engines was erected and forked that Mine in October 1778, which Engine in drawing the ſame Water from the ſame Depth conſumed, from the 31ſt of October 1778 to the 1ſt of November 1779, 54602 Buſhels, or 2*W*. 1*Q*. 6*B*. per Day of 24 Hours; difference 3*W*. 2*Q*. 10*B*.

Capt. *I. Broad* of Godolphin Mine, ſays that when that

Mine was wrought by an Engine of the old conſtruction their general average conſumption was 2¼ Weys, of 72 Buſhels, in 24 Hours. Boulton and Watt's Engine on that Mine conſumed, from the 31ſt of January 1787 to February 1ſt 1788, 19804 Buſhels, or 54 Buſhels (exactly ¾ of a Wey) in 24 Hours, ſaving 1½ Weys, being two thirds of the old Conſumption; this Mine was 62 fathoms deep, when Boulton and Watt firſt began to work, the Depth is now encreaſed to 89 fathoms and the Engine drew the Water, the laſt Month (July) with 28*W.* 2*Q.* Coals, which divided by 31, is only 66, 2 per Day or 3*Q* 12,2*B.* The old Engine at the ſame depth would, in proportion to the above, have conſumed 3*W.* 0*Q.* 16*B.* per Day.

I will now ſtate from authentic Documents to which reference may be had; that upon examining the Cuſtom-houſe Books at Truro, a Debenture or Drawback on Coals, was paid to the Adventurers of Treſavean Mine for 1917 Chaldrons of Coals, of 36 Buſhels each, from 31ſt of July 1768 to Auguſt 1ſt 1770, being two Years, which being reduced into Weys of 64*B.* is 1078*W.* 1*Q.* 4*B.* or 539*W.* 0*Q.* 10*B.* in one Year, conſumed on that Mine by one Engine of the old Conſtruction. Boulton and Watt erected one of their Engines on that Mine, which from the 31ſt of July 1780, to the 1ſt of Auguſt 1781, conſumed 120*W.* 1*Q.* 14*B.* difference 418*W.* 2*Q.* 12*B.* —— By the Cuſtom-houſe Books at Truro and Penryn it appears that a Drawback was paid to the Mines of Wheal Virgin, Wheal Maid and Weſ Wheal Virgin, from June 30th 1778 to July 1ſt 1779 for 6362*W.* 3*Q.* 12*B* of 64 *B.* conſumed by ſeven Engines of the old ſort, then working on theſe Mines In the latter end of 1779 theſe Mines ceaſed working and in September 1782 were again ſet to work by five of Boulton and Watts Engines; from the 30th o

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June 1783 to July 1ſt 1784 theſe Engines conſumed only 2030*W*. 3*Q*. 0*B*. though they muſt have drawn the water ſome fathoms deeper towards the latter part of the time, than the old Engines. The account reduced into Money will ſtand as under.

Dr. Seven Old Engines for 6362, 3, 12 Coals at 50s. per	15907. 6. 10½
By Five Boulton and Watts for 2030 3 0	5076 17 6
Saved to the Adventurers in Coals only - -	£10830 9 4½
To which may fairly be added the Expence in Wages and Repairs on Two Engines which it has been uſual to eſtimate at l.50 per Month each, at which rate it will amount for one Year to	1200 0 0
Total ſavings, to the Adventurers - -	£12030 9 4½’

I have always underſtood, but cannot poſitively ſay that in 1779 the Seven old Engines, by which thoſe Mines were then wrought, were unable to keep the Mine drained, ſo as to work regularly, and that it was neceſſary to ſeek the aſſiſtance of further Power, which (had not Mr Watt before this made his important improvements) muſt have been of the old conſtruction: this additional power to the Seven Engines then working, would have created ſuch an expence, as, it is evident from experience ſince, could not have been long borne if attempted; whereas the Five Engines built by Boulton and Watt, had power ſufficient to proſecute the Mine 20 fathoms deeper and, when that was expended, they by further improvements have enabled the Mine to continue near 10 Years by encreaſing the power, and reducing the number of *Five* to *Four* Engines; viz. by erecting on Wheal Maid Mine one Engine, in the Place of two firſt built on that Mine, which had got to the extent of their power. It may not be deemed amiſs here to add that Capt. *W. Paul*, Manager of the Conſolidated Mines, made a declaration at a public account in 1783, that he had examined the expence of drawing the water from theſe Mines, and found the whole (Boulton and Watts ſavings included) did not amount to ſo much as it had before coſt them, in drawing the water of Wheal Maid only by two of the Seven Engines formerly at work: this he candidly acknowledged he did in juſtice to the merits and character of Boulton and Watt

It is more than two years ſince I obtained from the Cuſtomhouſe the above accounts of conſumption of the old Engines, at the Conſolidated Mines, and it then occured to me that objections would be made to the bad ſtate in which thoſe Engines were. To obviate this, I procured from St. Ives the conſumption of two old Engines working upon Wheal Chance Mine, in Camborn; theſe were eſteemed very good ones, and if I recollect right were held out as extremely proper to calculate the ratio of Boulton and Watt's ſavings by through the County. From the 3rd of Octob. 1777, to October the 3rd, 1778, their conſumption was 1093*w*. 0*q*. 10*b*. of 72*b*. each; Boulton and Watt replaced thoſe Engines by one of theirs, which conſumed from September 30th, 1780, to October 1ſt. 1781, 439 Weys

Divide 407228 Buſhels conſumed by ſeven old Engines on Conſolidated Mines by 129968 Buſhels conſumed by Boulton and Watt's in the ſame time, and it will be found that the former exceeds the latter 3,133 times. Again divide 78,706 conſumed by two old Engines on Wheal Chance Mine by 31608 conſumed by Boulton and Watt's Engine in the ſame time, and the former is 2,49 times more than Boulton and Watt's. As 3,133 exceeds 2,49 ſo much better was the performance of Wheal Chance old Engines, than of the old Engines on the Conſolidated Mines, admitting the performance of Boulton and Watt's Engines on both Mines to be equal. It then follows that if 3,133 produce a ſaving in Coals to the adventurers of Conſolidated Mines, of *l.*10,839 9*s.* 4½ per annum. 2,49, the ſavings in Wheal Chance, will produce *l.*8607 13*s.* o*d.* the ſavings in Coals which would have been at the Conſolidated Mines had their old Engines been equally as good as thoſe on Wheal Chance Mine.

One third of *l*8607 13*s* o*d.* would then unqueſtionably be due to Boulton and Watt for their ſavings, at the beginning to work of thoſe Mines, viz *l.*2869. 4*s.* 6*d.* whereas their agreement is only for *l.*2500 and that ſum not to be increaſed let whatever power more be wanted. Where then is the juſtice of thoſe complaints, which have ſo much prevailed, that the County has been impoſed upon? and what credit is due to the aſſertions that Boulton and Watt have received four fifths of the real ſavings inſtead of one third, as firſt propoſed?

Suppoſing from the above ſtatement that the ſavings in Fuel at the Conſolidated Mines were only *l.*8607 13*s.* o*d.* per anm. let us examine what the ſavings will be in four other Mines only in that neighbourhood, in proportion to the quantities of water drawn at each Mine.

I have been formerly deſired by the Proprietors of thoſe Mines to aſcertain, from the accounts I take of the work done by the Engines, the water drawn at each Mine, in order to fix each Mines proportion of expence in repairing the Deep Adit, into which the water is delivered: the laſt account given into them was as under;

	Gall. per Min.	*Average Depth.*	*Savings.*
Conſolidated Mines	1421, 40	102	£8607, 13 0
United Mines	1296, 46	95	7311, 18 0
Poldice	1233, 58	97	7103, 12 0
Chacewater	932, 34	60	3321 0 0
North Downs	1819, 41	55	5940, 19 0
			£32285, 2 0

Thus it appears that the ſavings of Fuel alone on theſe Mines, (the ratio being calculated from Wheal Chance) would be l.32 285, 2s. od. one third of which Boulton and Watt's part is l10 761, 17s. od. whereas if all thoſe Mines had paid their full ſavings *according to agreement*, it would have amounted to l.8700, os. od only; but if the ſavings on theſe Mines were calculated *by the performance of the Engines* on the Conſolidated Mines, they would then amount to l40 622, 5s. od. one third of which would be l.13540, 15s. od. half as much more as the Sums agreed for; and nearly four times the Sum Boulton and Watt are actually receiving from theſe Mines which are all, except Chacewater, now working.

Further, I have now in my poſſeſſion an atteſted Copy of a Certificate dated Poldice Mine October 30 1778, That in 61 Days (the Months of Auguſt and September that Year,) Two Steam Engines then in working on that Mine, drawing together 58 Fathoms of 17 Inch Pumps, Six Strokes per Minute of 5½ feet long each, burnt 14080 Buſhels of Coals, ſigned by the Revd H. Hawkins Tremayne, John Williams Purſer, Richard Williams *firſt Captain* and Thomas Brown, *Coal Wheeler*.

An Engine on that Mine from the 29th of February to 1ſt of July laſt, of Boulton and Watt's Conſtruction, drew 90½ Fathoms of 17, 9 of 13 and 17 of 6 Inches Diameter, equal to 98 nearly of 17, 6 feet Stroke and 7, 73 ſtrokes per Minute, and burnt in 122 Days 17648 Buſhels of Coals; 61 Days conſumption is 8824B,

By arithmetical deduction it will appear that had the old Engines done as much work as that of Boulton and Watt's now in working and gone at the ſame rate, without noticing the length of Stroke, they would have conſumed 30, 649B. in 61 Days, whereas the preſent Engine only conſumed 8824 Buſhels, the former exceeding the latter 3, 47 times, a greater proportion than above ſtated at the *Conſolidated Mines*.

But perhaps the faireſt trial of the real Comparative merits of theſe two kinds of Engines, was made at Hawkſbury Colliery near Coventry.

Boulton and Watt had erected in 1776 one of their Engines on that Colliery, on their uſual Terms of being paid one third of the fuel ſaved thereby this account remained unſettled till 1779, the old Engine which had before drawn their Water was ſtill ſtanding and it was agreed that a fair trial ſhould be made by each working 48 Hours, and as the water was drawn to the ſurface, a pool was made to receive the water from each Engine whereby the number of ſtrokes it would require to fill it by each Engine might be aſcertained, and ſix months from this agreement were allowed for each Engine to be put into the beſt poſſible order. This experiment commenced on the fifth and ended on the ſeventh of march by the old Engine and was begun the 12th and ended the 14th ſame month by Boulton and Watt's Engine: the reſult was as under;

	cwt.
Old Engine drew 84124 Cubic feet of water, and burnt	348 Coals
Bonlton and Watt's Engine 99711 - - - - and burnt	96 1 12
If 84124 requires 348 then 00711 will conſume	412, 65
deduct Boulton and Watt's real conſumption	96, 3
difference	316, 35

the former exceeds the latter 4, 284 times which is much more than appears from any ſtatements in Cornwall.

I have the preſs copy of the Original Certificate, which is drawn at great length, and ſigned by Matthew Boulton, George Taylor, the active partner in the Colliery, William Plant Clerke, and Logan Henderſon, and bears date Hawkſbury March 15, 1779.

The two laſt named certificates, it will give me pleaſure to ſhew to any perſon who may be deſirous of ſeeing them.

I

I have, I hope, in the foregoing ſtatements ſufficiently evinced the ſuperiority of Boulton and Watt's, over Newcommen's the only Engine in uſe or at leaſt capable of draining deep Mines, before theirs. I would beg leave before I totally quit this ſubject, to make a few reflections that naturally ariſe from it; and hope to be underſtood that in doing this I mean no offence to a ſingle indivedual.

It is obvious that unleſs Boulton and Watt's improvements had been brought into uſe at the time they were, this County could not have had the benefit of working their deep Mines, particularly thoſe I have before mentioned as it is evident from experience that they could not have ſubſiſted under the enormous expence of the old Steam Engines.

I muſt confeſs that in dependently of any ſums I have received or may receive for actual ſervices, I conſider myſelf as highly indebted to Boulton and Watt for if by their means Fenton and Co. had not been able to proſecute Chacewater Mine, that Co. muſt have inevitably ſuſtained the heavy loſs of 50 or *l.*60,000 capital, whereas that ſum was totally recovered from the year 80 to 1784 and entirely through and by means of Boulton and Watt's improvements; may I not without impropriety aſk whether there be not many others who if they turn circumſtances in their minds, muſt make the ſame acknowledgments.

The Lords of Mines and Merchants muſt be conſidered as particularly benefited, but may not the numerous working people be deemed the moſt indebted of any and when the natural conſequences of conſumption of every ſort, are conſidered whither may not the good effects be irradiated, the landed Intereſt, the Farmer, the Shopkeeper, the Collieries in Wales, Shipping, Copper works with their various dependencies, duties and

Exciſe paid to Government for all articles of conſumption in the Mines, as well as by the people whom they ſupport; the account is already ſwollen to an immenſity not eaſily concentrated, and cannot but convince every candid mind, that it is an improvement cauſiing more beneficial conſequences then were ever effected by the genius of one Man, ſince the commencement of Mechanic arts, but if the view of Mr W's improvements be extended beyond this County, and the various applications of his Engines be alſo properly conſidered, there is no doubt but that, as a national Benefit it is unequalled. I forbear to enter further into this ſubject, many other circumſtances might be mentioned but my wiſh is only to ſtate ſuch facts as tend to do away the prejudice, which partial repreſentations may have raiſed in the minds of many, who have not been well informed of the real merits of the caſe.

Before I enter upon a compariſon of Boulton and Watt's Engines with Mr. Hornblower's, it will be neceſſary to explain my ideas of the proper manner of making ſuch a compariſon. The Engines to be compared ought to be as nearly as poſſible in ſimilar circumſtances. Now it ſo happens that there is no Engine of Boulton and Watt ſo advantageouſly circumſtanced as Tin Croft Engine of the conſtruction of Mr. Hornblower. For the power of an Engine is not wholly expended in raiſing the water, but a very great proportion of it is employed in overcoming the vis inertiæ of the pump rods, the reſiſtance of the water in paſſing through buckets and clacks; and the friction of various kinds, which may ariſe from the particular diſpoſition or ſituation of the pumps; beſides theſe, it is neceſſary that the Engines to be compared ſhould be as nearly as poſſible under the ſame load in proportion to the power of each, but the moſt material requiſite is, *that* *they ſhould be working at the ſame rate, or number of ſtrokes per minute.* This will be evident from the ſlighteſt inſpection of the effects of Tin Croft Engine per buſhel of coals, which I intend to ſtate, when under different loads and at different rates of working. Laſtly Engines to be compared ought to be nearly of the ſame ſize; for the advantage of large over ſmall Engines cannot be denied, although Mr. Hornblower has held it out to be much greater than it really is; In one of his publications, he ſays "Mr. Hornblower not having yet made very large Engines, has it not in his power to compare, on fair grounds, his machine with ſome very powerful ones of Meſſrs. Boulton and Watt, therefore the latter may ſeem to leſſen the merit of Mr. Hornblower's invention, but the only poſſible way that a juſt compariſon can be made, muſt be between Engines of the ſame magnitude, becauſe the advantages in favour of large Engines are *on various accounts* very great." I quote this becauſe it ſhews that we agree in our Opinions of a fair compariſon with reſpect to the difference between large and ſmall Engines. In my opinion it conſiſts only in the friction of the piſton in the cylinder and the expoſure of the ſurface to the condenſation of the atmoſphere, the friction of every other part of the Engine being in proportion to the power. An Engine of 60 inches diameter is of four times the power of one of 30 whilſt the circumference of the piſton, and expoſure of Surface are only as two to one, to what that may amount I cannot ſay, but I conceive thoſe which I have ſtated are the only advantages. Mr. H. Williams, a practical Engineer, ſays that he has made an experiment upon a 66 inch Cylinder of Boulton and Watt at Coal Brook Dale, and he found that 8 *cwt.* made the piſton, when properly packed, move through the cylin-

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der, as faſt as it uſually worked; if ſo, the difference is not extraordinary.

It was really unfortunate that Boulton and Watt had no Engine working in the County which Mr. Hornblower would admit as proper in reſpect to ſize, to be compared with Tin Croft Engine when he firſt ſet it to work, but what were under extremly diſadvantageous circumſtances and very unfit ſubjects of compariſon: The two which might have been allowed by him were; one of 24 inches upon Poldice Mine. This Engine is loaded with two Rods perpendicular about 100 fathoms, each of which Rods works, at that depth, a half wheel: theſe wheels together draw flat Rods from 50 to 60 fathoms and then raiſe water from pumps diagonally upon the underlay of two loads. This machinery muſt unavoidably produce much friction which it requires a great deal of the power of the Engine to overcome. The other Engine was one of 20 inches diameter ſet to work on Seal hole Mine in St. Agnes in June 1791. This Engine has alſo near 80 fathoms of dry Rods, and works pumps 87 fathoms long, in five lifts: The friction of ſo many buckets is a great drawback on ſuch a ſmall Engine, but the greateſt diſadvantage is uncommonly bad water, which precipitates a ſediment that has, in the ſpace of one year, burnt out two boiler (I have in my poſſeſſion a lump of this two inches thick produced in 14 days) It cannot be expected that coals can, through ſo thick a ſubſtance, evaporate water with ſo much effect, as where no ſuch complaint exiſts.

I muſt now beg leave to ſtate the grounds I have for concluding the performance of Tin Croft Engine to be as under.

The conſumption of coals, from its ſetting to work to the end of February laſt, was procured me by a friend. In March and part of April by the Captain of the Mine. The depths in March 1791, from Memorandums taken at the time. The depth it worked the 22nd May 1791, from Mr. Hornblower was 10 fm. one ft. and the depth in March laſt was $27\frac{1}{2}$ fathoms. I can only then divide the $17\frac{1}{2}$ fathoms ſunk from May to March by the intermediate months to find the Monthly average; $17\frac{1}{2}$ fms. by 9 is. *1fm. 5ft. 8ins..* The rate of going I can only aſcertain from my own obſervation during laſt ſummer, and the information of others, particularly one of the Engine men, who acknowledged it to be four ſtrokes per minute 'till November, when the water increaſed; the particulars of its performance in Feby. March and April 1792, are, I beleive juſt, as 'though not acknowledged by Capt,. Joſeph Vivian to be ſo, they were not contradicted when ſhewn to him. I wiſh it were in my power to ſtate from better authority the real depths at the time, but all my late applications for infomation, although many, have been without effect. As it will not be neceſſary for my preſent purpoſe to calculate the effects of every month, I will content myſelf with inſerting the load of each month as far as in my power together with the comſumption and rate of going.

	Depth of Pump.			*Coals conſumed*			*No. of Srokes.*
	Fm.	Ft.	In.	W.	Q.	B.	
Feb. 14 to the end.	5	3	0	4	1	2	3
March	6	3	0	5	2	7	4
April	8	0	0	4	1	9	4
May	10	1	0	4	0	0	4
June	12	0	0	3	2	0	4
Juy	14	0	0	4	3	0	4
Auguſt	16	0	0	4	2	9	4
September	18	0	0	5	0	5	4
October	20	0	0	5	2	9	4
November	22	0	0	6	0	0	not known.
December	24	0	0	7	2	0	ditto
1792 January	26	0	0	7	0	0	ditto
February	27	3	0	8	1	0	8

Performance and Effects of Tin Croft Engine

Dates	Depth in faths.	Diar. of pumps	Load in pounds	Len. of Stro.	Strks. per min.	Confump monthly	Con. per day	Strks per bufh.	Pds. wt. 1 foot high	Effect per bufh. 1 foot high
	Fms.Ft.	Inches		Feet		W. qrs. bs.	Bufhs.		Pounds	Pounds
March 1791	6 . 3	8	850,85	6	4	5 . 2 . 7	13	443.08	5105.1	2,261,967
July	14 . 0	8	1832,6	6	4	4 . 3 . 0	11,03	522,21	10995,6	5,742,012
Febry. 1792	22 . 0	8½	3251,16							
	5 . 3	8	719,95							
			3971,11	5½	8	8 . 1 . 0	20,48	462,5	21841,1	12,285,618
March	ditto	8	ditto	5½	8	8 . 3 . 0	20.32	566,9	ditto	12,381,719
18½ days	17 . 2	8½	2561							
in	6 . 0	8	785,4							
April	4½	6	55,2							
				5¾	11½	4 . 1 . 0	22,6	732,7	19559,2	14,331,021
Cp Trevithick's			3401,6							
Trial of 24hours	ditto	do.	ditto	do.	do		19,5	849,2	ditto	16,609,672

From the above ſtatement it muſt be admitted that it will be very unfair to compare the effects of Engines with each other, but under nearly ſimilar loads and ſtrokes per minute for 'though the load in April is leſs than in February and March, yet from the increaſed number of ſtrokes the effect is ſuperior.

I ought to explain that the depth being leſs in April was owing to an Adit of 5 fathoms being brought in the latter end of March.

Meſſrs. Boulton and Watt erected the laſt ſpring an Engine upon Wheal Jewell Mine of 20 inches Diameter which was ſet to work in June laſt. A Counter was put on the beam at three o'Clock in the afternoon July 11th, and was taken off at ¾ paſt three on the firſt of Auguſt: It then ſtood at 00617060. eleventh of July it ſtood at 00358040

259020

but, as this Engine makes two ſtrokes in the cylinder for one in the pump, the ſtrokes in the pump will be 129510, made in the above ſpace of 21 days and ¼ of an hour (viz.) 30285 minutes, 4,27 ſtrokes per minute, which may be deemed the average rate of working through the month.

The account of the load ſent me ſigned by the captain is as under.

	F.	F.	I.	inch		F.	I.		load		llb. 1 foot high
North Shaft	10	5	10	9	box	3	10	ſtro.	1817.643	1 ft. high	7043.36
South ditto	9	4	0	9¼	—	3	9	—	1691,6	—	6343,5
Houſe wat.	8	3	0	6$_{8}$	—	3	6	—	654	—	2289
Puppy	—	4	1	0 6$_{4}$	—	3	9	—	333	—	1248 7
									llb. 4406, 2		16924, 56.

Coals conſumed in 31 days of that month are 319 B. or 10, 29 per day, multiply the minutes in 24 hours, 1440, by 4, 27, and the Product 6148,8 divided by 10, 29 Coals conſumed in 24 hours, gives 597, 5 ſtrokes per buſhel, which ſum multiplied into 16924, 56 lbs. raiſed 1 foot high, produces 10,112 424 lbs. raiſed 1 foot high per Buſhel. I underſtood that, ſome days after the 11th of July, the water in Wheal Jewel did not ſupply the Pumps at the rate at which the Engine was then working, which from the nature of its conſtruction cannot work ſlower. Aware that an objection might be made on that account to the performance, I got leave to put dow landers from the adit to the pumps to keep the pump perfect perfectly ſupplied. The Trial commenced in this ſtate at Three o'Clock in the afternoon of the 25th July and continued to the ſame time on the 28*th.*, 72 hours; in which time the Engine made 18650 ſtrokes, and conſumed 30 buſhels of coals, which gives 621,66 ſtrokes per buſhel and multiplied into 16924, 56, as before, produces 10 521 321 *lbs.* weight raiſed per buſhel of coals.

On the 28th, when the laſt Trial terminated, it was neceſſary to ſtop the Engine in order to make ſome alterations in the pumps; the water was again in fork the 29th, at 12 at noon, from which time to ¾ paſt 3 on the 1ſt of Auguſt, the pumps being perfectly ſupplied as before, it made 20295 ſtrokes in the pump, and burnt 34 buſhels of coals; which is 596, 9 ſtrokes per buſhel and produces 10102269 *lbs.* weight raiſed 1 foot high per buſhel. Wheal Jewell 20 Inch Cylinder 42 *lb.* to the inch, the whole power is 13194 *lbs.* preſent load 4496, 2 *lb.* little more than one third of it's whole power.

Tin Croft 21 Inches Cylinder, 16 *lb.* per inch, the whole power is 5541, 7 *lbs* load in July 1791, 1832,6 *lb* nearly one third of it's power. The rate of going is alſo nearly the ſame, ſo that the performance of Wheal Jewell, in July 1792, may be deemed a fair compariſon with the performance of Tin Croft in July 1791; and it will appear, this admitted, that taking the loweſt of Wheal Jewell, it exceeds Tin Croft as 10 102 269 exceeds 5 742 012. In ſelecting the month of July 1791 at Tin Croft, I had in view the following part of Meſſrs. Hornblower and Winwood's Advertiſement of the 30th of July 1791, viz "Meſſrs. "Hornblower and Winwood have, by their Engine at "Tin Croft, exhibited a Machine which evidently "ſurpaſſes every other of the kind in a double proportion"

tion." I would further obſerve, that Wheal Jewell works 108 fms. 2 feet of flat, and 90 fms. of perpendicular Rods ; Tin Croft only 28fms. perpendicular. Wheal Jewell has the friction of 4 buckets, Tin Croft had in July 1791 at moſt 2. Wheal Jewell being rotative, muſt make the exact length of it's ſtrokes ; whereas Tin Croft, working reciprocally, cannot eaſily be kept to it's length of ſtroke ; and though I have in that month, called it 6 feet, I doubt it's ever being ſet to more than 5f. 10in. Theſe circumſtances cannot be deemed advantages on the part of Wheal Jewell.

Leſt it ſhould be imagined, that Wheal Jewell is of a conſtruction, ſuperior to others of Boulton and Watt's Engines, I would obſerve, that it is built upon the very ſame Principles as all their other double-Engines are, with the addition only of rotative work, which is calculated to combat the *vis inertiæ* of flat and dry Rods, not differing in the ſmalleſt matter from Seal Hole Engine ; and which addition to that Engine has been highly condemned by Mr. Hornblower's friends, as producing much friction without adequate benefit. That it produces friction is beyond doubt. But I will notice a nother circumſtance attending theſe Engines of worſe conſequence, for at every foot ſtroke made in the pumps, the ſteam and exhauſtion Valves muſt open ; whereas Tin Croft Valves only open once in every 6 feet of ſtrokes made in the pumps. The opening of the Valves ſo often muſt ſubject the Engine to a waſte of ſteam.

Boulton and Watt had an Engine working ſome years ago upon Treſavean Mine ; the diameter o which was 28 inches ; not very objectionable on account of it's ſize, as it is only one inch larger than th largeſt of Mr. Hornblower's Cylinders on Tin Croft This Engine, in February 1785 drew 71 fms. o

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ſix inch Box 5227*lbs* and 27½ of five inch 1405*lbs*, in the whole 6632*lbs*; made 309220 ſtrokes, burnt 606 Buſhels of Coals, 21, 64 per day, ſix feet ſtroke, 7, 66 ſtrokes per minute effect 20304265*lbs* per Buſhel. The whole power of this Engine, working eight feet inſide, and ſix in the pump, is 8620*lbs*, the load 6632*lbs*, is not much above ¾ of it's power. The power of Tin Croft Engine being as before 5541,7*lbs*, it's load in February and March laſt, 3971*lbs*, is alſo more than ¾ of the power. The rate of Tin Croft Engine in theſe months is 8 ſtrokes, that of Treſavean 7, 66 ſtrokes not materially different. Theſe Engines, therefore, are proper to be compared together. Hence it appears that Boulton and Watt's Engine exceeds Meſſrs. Hornblower and Winwood's, as 20304265, exceed 12381719; nearly in the proportion in which Wheal Jewell exceeds Tin Croft as before. The performance of this Engine was pretty much the ſame for four months together, whilſt under the ſame load and number of ſtrokes; and it is to be obſerved that ſhe was burthened with the friction of 5 if not 6 buckets. I underſtand that Mr. Hornblower objects to any compariſon which may be drawn from Treſavean, becauſe the Engine is not now working; I am therefore obliged to ſtate that the Adventurers paid the premium for this Engine, by calculations made from Tables formed for that purpoſe; that two Counters were fixed upon the Beam, the key of one of which was kept at the Mine; that the load was ſpecified by the Captains or Pitman; and that the quantity of Coals conſumed was taken from a book, which was ſworn to by the perſon who made the entries. It is not to be ſuppoſed, that the Clerk, who regularly attended the taking of the counters, would permit the number of ſtrokes to be exaggerated, or the load to be given more than it really was, or cauſe the quantity of Coals to be called leſs; becauſe all, or any of theſe, would ſubject the Adventurers to a larger payment than juſt. The Clerk on that Mine regularly aſſiſted in making the Calculations, and kept a duplicate of the accounts now in my poſſeſſion: which duplicate Mr. John Williams of Scorrier Houſe authorizes me to ſay that he has. Theſe accounts, which cannot have been now made for the purpoſe of compariſon, can be further authenticated upon the oaths of G. Vivian and the Clerk of the Mine, and muſt therefore be deemed as good and ſufficient evidence of the effects of the Engine, as if ſhe were in actual working.

Seal-Hole Engine, though under the unfavourable circumſtances before ſtated, and more particularly in June laſt, when working with a boiler, which it was neceſſary to take out, and repair immediately afterwards, did in that month make 308715 Strokes of 4 feet long, under a Load of 7055*lb*, and burnt 8*W*. 2*Q*. 13*B*. of Coals; which amounts to 7,14 ſtrokes per minute and 20,83 buſhels of Coals in 24 hours; 493,94 ſtrokes per buſhel, and 28220 *lbs.* 1 foot high Theſe multiplied together give 13938986*lb* 1 foot high per B. This Engine is little more than ½ loaded, and works nearly 1 ſtroke per minute leſs than Tin Croft did in March laſt, and yet produces a better effect, as 13938986 exceeds 12381719. Further; by way of compariſon with the effect of Tin Croft in April, in Captain Trevithick's trial of 24 hours, I muſt beg leave to produce the performance of Shadwell Water Works Engine, as there are no Engines in this County of equal ſize that have worked at the ſame rate. This Engine is 27 inches diameter, load 15 fms. of 12⅝ inches. 4875*lb* wrought 16, 1 per minute of 8 feet long each, made 776 ſtrokes per buſhel of Coal, and produced an effect of 30264030*lb.* 1 foot high per buſhel. But as this may be objected to, on account of the rate of going, I will give the effects of ſome large Engines in CORNWALL nearly upon par with Tin Croft as to number of ſtrokes. Ale and Cakes-Engine, July 1786, working 10,4 ſtrokes raiſed 31338850*lb.* per buſhel. Polgooth, in December and January 1785, working 11,05 ſtrokes raiſed 29225750*lbs.* per buſhel. I leave deductions to be made for ſize. But to ſhew, that the advantage derived from it is not ſo great as has been repreſented, I will ſtate the yearly averag eperformance of ſome large Engines actually ſelected to be given in evidence before Parliament this Spring, if ſuch teſtimony had been permitted.

		lbs.
1783	Wheal Virgin Eaſt	22930414
1783	Poldice Eaſt	21304762
1784	Ditto	21630795
1784	Dolcoath	22646554
1785	Ditto	22396891
1786	Poldice	21652429

Theſe are not ſo materially above the performance of Treſavean, as to make the ſize ſo great an object as it has been repreſented. It is true, that the large Double-Engines have exceeded the above conſiderably,

In 1789 Wheal Maid 6,71 Strokes per Minute 26116034*lbs.*
1790 Ditto 6,83 - 25231695

and Poldice, in four months, begining March the 1ſt, and ending June the 30th, laſt, produced an effect at 7,73 ſtrokes per minute, of 26737339*lbs.* Will Mr. Hornblower undertake to erect an Engine of his conſtruction, equal to Wheal Maid in power? To produce that power, will it not require Two as large Engines as he would wiſh to try? And will not theſe, with their Apparatus, coſt much more than Wheal Maid, and when erected, conſume much more fuel? The power of Tin Croft Engine 16*lb.* to the Inch of the ſmaller Cylinder is 5541,7*lbs.* the larger Cylinder is 17 Inches, with a ſtroke of 8 feet inſide and 6 out.

It's power at 10½*lb.* to the Inch, is 8015,7*lb*, and it will work a pump of 9⅜ Inches diameter nearly 45 fms. whilſt the Engine in it's preſent ſtate, when loaded to 16*lb.* will only work 30¾ fms. Detach the ſmaller Cylinder from the Engine, and conſtruct the other as it ſtands on Boulton and Watt's principles, and it is evident that the Engine will enable the Adventurers to ſink nearly half as much more than Mr. Hornblower pretends to do

When this Engine is loaded and working ſtrokes per minute, the effect of 23084928 *lbs* will be produced by 24 buſhs. of Coals conſumed in 2 hours, which, from experience in other Engines, Boulton and Watt may ſafely guarantee, when the peculiar circumſtances of the few dry Rods and Buckets good water &c, of Tin Croft are conſidered. Th expence of altering this Engine will not exceed *l*100 and when it ſhall have attained the depth of 45 fathom it may again at a like expence be altered to go to th depth of 90 fathoms, by making it work double, pr vided the water do not increaſe.

From the whole of what is here ſaid, it may be fair deduced, that this County hath been theſe ten yea indebted to Mr. Watt for the power of working i deep Mines.

I am ready to acknowledge, that the ſtate of t Mines, on account of the increaſed expence natural attending their increaſed depths, is ſuch as to requ the adoption of every *Improvement.* I think I ha pretty clearly evinced, that very little is to be expe ed from Mr. HORNBLOWER: to whom then muſt County reſort? If any aſſiſtance can be afforded muſt be by the efforts of their old and beſt friend Mr W

I well know, that what he has already done, was fruit of a long and continued application of his me powers: witneſs his having clearly known the pri ples in 1769, tho' it took him 6 Years to contrive mechanical apparatus to put thoſe principles into practice. Since that time he has been much employed in ſtill further improving the mechanical parts of his own Engines. Theſe efforts of mind, and this laborious application, have greatly injured his conſtitution; and tho' he has been rewarded with moderate profits (which by the bye, public report and public aſſertion have much exaggerated), yet, in my mind, had they been much greater, he would not have been repaid for the loſs of health, without which he cannot enjoy his well-earned independence.

Suppoſing an improvement equal to that made by Mr. Watt were now to be propoſed; would not the County ſubmit to pay the Inventor for a term of years the ſame proportion of ſavings Boulton and Watt agreed to take; and though a ſuperior improvement even to this ſhould be offered to the public before the expiration of his term, yet that he ſhould ſtill enjoy his profits to the end of that term? But I have been here arguing upon an impoſſible caſe, for I find that the Coals conſumed at the Conſolidated Mines in one year ending the firſt Inſtant are only 2856*W*. 0*Q*. 6*B*. which at 50*s*. per wey amounts to *l*7140 14*l*. 9*s*. If it be poſſible to ſave out of *l*7140 14*s* 9*d*. the ſum of *l*10840 13*s*. 9*d*. it will be alſo poſſible that there may ariſe a man capable of rendering to this County the like ſervices to which they are now indebted to Mr. Watt.

I had nearly forgot to anſwer an objection made againſt calculating by ſtrokes taken from Counters under an idea that they take in *parts* of, as well as *whole ſtrokes*. All who underſtand the conſtruction of theſe machines know that they cannot poſſibly enumerate more ſtrokes than are really made, and I believe an Engine muſt at leaſt make two-thirds of a ſtroke before the pendulum will vibrate paſt it's center? I apprehend the objection lies againſt the ſtrokes which are made when an Engine ſets to work, and before the pumps are filled with water; Theſe parts of ſtrokes happen ſeldom and when they do, it is not clear that many are marked; however thoſe who doubt may ſatiſfy themſelves by enquiring at an Engine how often and what number of ſuch ſhort ſtrokes are uſually made at a time, and I am ſatisfied on enquiry the number will be found ſo trifling when compared with the number in a month as entirely to obviate that objection. Further let any man (not knowing for what reaſon) be deſired to pay attention to the rate of an Engine's going when in fork, as often during the courſe of a month as he pleaſes, ſay two or three times a day, let him put down his obſervations, and I will engage that the average of thoſe will be found to be much more than the Counter will ſhew. I have obſerved this in an hundred inſtances.

I have been led into much greater length than I at firſt intended, willing to do juſtice to the ſubject. My aim has been at clearneſs, and, if I have made myſelf underſtood, the end will be anſwered. The authorities for the facts which I have ſtated can be eaſily appealed to and the truth aſcertained. The deductions from thoſe facts are, as far as I know, ſtrictly right if not detection is eaſy. The very high opinion I entertain of Mr. Watt's abilities will, I truſt, excuſe what I have ſaid in his favor; to have ſaid leſs would not have been doing him common juſtice. I have avoided, as much as poſſible, any reflections on Mr. Hornblower, 'though a little more might have been juſtified by his example. My wiſh is to deprecate the prejudice of the public, and to reſt the merits of the ſeveral parties on the truth or falſehood of the particulars herein diſcuſſed.

I am

Your moſt obedient humble Servant

THOMAS WILSON.

TRURO 6th, Auguſt 1792.

P. S. Since the above went to preſs, I have received a copy of a Letter from S Bull, Superintendant of the Locks of the Birmingham Canal, dated the 17th, and inſerted in the Birmingham Gazette of the 20th, of *April* 1778, addreſſed to the Committee of that Canal. — As it contains the opinion of that able Engineer, MR. JOHN SMEATON, as to a Steam Engine of Meſſrs. Boulton and Watt's invention then lately erected on the Canal, I cannot refrain from communicating it to the public.

It ſtates, that Mr. Smeaton on the Wedneſday before the date of the Letter, made an accurate trial of this Engine: that it did not conſume more than 64*lbs.* weight of Coals per hour, when working at the rate of 11 ſtrokes a minute, (each ſtroke being 5*ft.* 10*ins.*): that the diameter of the working barrel of the pump was 20 *Inches*, and the perpendicular height of the column of water 26*ft.* 10½*ins.* equal to 11$\frac{3}{7}$*lbs* to every ſquare inch of the Piſton: the diameter of the Cylinder being 20 *Inches* equal Beam.

It further ſtates, that Mr. Smeaton declared that the beſt new Common Engine, with all his late improvements, would have required 194*lbs.* of Coals to do the ſame work: and that a common Engine, without his improvements, would have conſumed a ſtill greater quantity. According to this ſtatement the effects amounted to 26½ millions of pounds 1 foot high for every 120*lb.* of Wedneſbury Coals, — not equal to a buſhel of Newcaſtle or beſt Welch Coals in their effect. The Certificates and Copy of Letter above refered to, may be inſpected at the Office of *Mr. John Edwards* Junr. *Attorney*, *Truro*, during my abſence from Cornwall.

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